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# PHYSIOLOGICAL FEATURE EXTRACTION AND FUSION TO ASSIST IN THE DIAGNOSIS OF POST-TRAUMATIC STRESS DISORDER

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 61/819,095, filed May 3, 2013 and titled “PHYSIOLOGICAL FEATURE EXTRACTION AND FUSION TO ASSIST IN THE DIAGNOSIS OF POST-TRAUMATIC STRESS DISORDER,” which is incorporated herein by reference in its entirety.

## BACKGROUND

Post-traumatic stress disorder (PTSD) currently is diagnosed via subjective reports of experiences related to the traumatic event. More objective measures are needed to assist clinicians in diagnosis.

## SUMMARY

According to one aspect of the disclosure, a method for diagnosing psychological trauma includes exposing a subject to a stimulus and collecting, with a plurality of sensors, a plurality of physiological signals. The physiological signals are collected during the subject's exposure to the stimulus. The plurality of physiological signals includes at least an interbeat interval signal and a skin conductance signal. The method also includes extracting a feature from each of the plurality of physiological signals, and classifying the subject into one of a plurality of diagnostic categories based on a function of the extracted features.

In some implementations, a first category of the plurality of diagnostic categories indicates the subject is suffering from post-traumatic stress disorder, a second category of the plurality of diagnostic categories indicates the subject is not suffering from post-traumatic stress disorder, and a third category of the plurality of diagnostic categories indicates the subject was exposed to a traumatic event but does not suffer from post-traumatic stress disorder.

In certain implementations, the extracted features include at least one of an area to full recovery, an area to half recovery, a peak amplitude, a standard deviation, a rise time from a first low point, a rise time from a response onset, a rise rate from a first low point, and an average value. In some implementations, the physiological signals includes at least one of a respiratory rate signal, a finger pulse amplitude signal, an electrocardiographic signal, an electrodermal activity (or skin conductance) signal, and an electroencephalographic signal.

In some implementations, the stimuli include at least one of audio stimulus and visual stimulus. In some implementations, the stimuli are presented to the subject via a virtual reality display device. The method can also include selecting the stimuli based on a traumatic event previously experienced by the subject.

In certain implementations, classifying the subject includes applying weights to the extracted features, combining the weighted features, and comparing the combined weighted features to a threshold. The threshold can be selected responsive to a baseline response of the subject and demographic characteristics of the subject, including, for example, at least one of an age of the subject, an ethnic background of the subject, and a sex of the subject.

In some implementations, the classification of whether the subject is suffering from post-traumatic stress disorder is

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made with one of a neural network, a Bayesian network, a linear discriminant classifier, or a support vector machine.

According to another aspect of the disclosure, a system for diagnosing psychological trauma includes an analog to digital converter (ADC). The ADC is configured to record a plurality of physiological signals during a subject's exposure to a stimulus. The plurality of physiological signals includes at least an interbeat interval signal and a skin conductance signal. The system also includes a feature extraction module configured to extract a feature from each of the plurality of physiological signals. The system further includes a classification module configured to classify the subject into one of a plurality of diagnostic categories based on a function of the extracted features.

In some implementations, a first category of the plurality of diagnostic categories indicates the subject is suffering from post-traumatic stress disorder, a second category of the plurality of diagnostic categories indicates the subject is not suffering from post-traumatic stress disorder, and a third category of the plurality of diagnostic categories indicates the subject was exposed to a traumatic event but does not suffer from post-traumatic stress disorder.

In some implementations, the system includes a stimulus delivery system. The stimulus delivery system is configured to expose the subject to a plurality of audio and/or visual stimuli. In certain implementations, the stimulus delivery system includes a virtual reality display and maybe configured to select the presented stimulus based on a traumatic event previously experienced by the subject.

In certain implementations, the classification module is configured to classify the subject using at least one of a neural network, a Bayesian network, a linear discriminant classifier, or a support vector machine. In some implementations, the classification module is configured to classify the subject by applying weights to the extracted features, combining the weighted features, and comparing the combined weighted features to a threshold. The threshold maybe selected responsive to at least one of an age of the subject, an ethnic background of the subject, a sex of the subject, and a baseline response of the subject.

In some implementations, the extracted physiological features includes at least one of an area to full recovery, an area to half recovery, a peak amplitude, a standard deviation, a rise time from a first low point, a rise time from a response onset, a rise rate from a first low point, and an average value.

## BRIEF DESCRIPTION OF THE DRAWINGS

The skilled artisan will understand that the figures, described herein, are for illustration purposes only. It is to be understood that in some instances various aspects of the described implementations may be shown exaggerated or enlarged to facilitate an understanding of the described implementations. In the drawings, like reference characters generally refer to like features, functionally similar and/or structurally similar elements throughout the various drawings. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the teachings. The drawings are not intended to limit the scope of the present teachings in any way. The system and method may be better understood from the following illustrative description with reference to the following drawings in which:

FIG. 1 illustrates a block diagram of an example system for diagnosing psychological trauma.

FIG. 2 illustrates a block diagram of the example diagnostic system from FIG. 1.